EXECUTIVE SUMMARY

In 2001 the Energy Branch of the Department of Minerals and Energy commissioned a survey to establish an inventory of the discard and duff coal in South Africa. The objectives of the project were to:

- update the 1985 National Inventory of South African Discard and Duff coal;
- compile an electronic data-base of the inventory; and
- to produce a Geographical Information System (GIS) of the inventory.

To compile the inventory the appointed consultants prepared a detailed questionnaire which was approved by the National Discard Coal Steering Committee (NDCSC) before being distributed to the coal mining industry.

The response was good, particularly from the mining houses although the level of detail, particularly with respect to quality of the different size fractions was poor. Retrieving the returns and following up on information not provided in the format of the questionnaire proved to be a time-consuming task and delayed the project somewhat. Returns covering 142 discard dumps and slurry ponds were received.

All the questionnaires were converted into digital spreadsheets which formed the input of the database and in turn the database formed the platform of the geographical information system. The self-executing GIS was presented to the National Discard Coal Steering Committee (NDCSC) and the Energy Division in June 2002.

To conclude the survey and make the results available to a broader base, it was decided to produce a Summary Report of the inventory but maintaining the
confidentiality of the information in the data-base. I.e. the Summary Report does not attempt to record the details of the data-base and the GIS.

Notably, since the last National Inventory of South African Discard and Duff Coal was tabled in 1985 it has been estimated, using the monthly returns sent to the Energy Division from the collieries, that a further 845.5 million tonne of discard and slurry have been produced and dumped. Therefore the register records an enormous 1,120.853 million tonne at the time of writing.

The 2001 questionnaires indicate that the current annual discard and slurry production is in the order of 53.793 million tonne. This figure is some 12.466 million tonne lower than the Energy Divisions’ register. It has been noted that certain survey questionnaires reported a lower annual tonnage than the same mines’ monthly returns. Also:

- nineteen smaller mines did not respond to the 2001 survey;
- a group of KwaZulu-Natal mines were in liquidation at the time and did not respond; and
- mines that had scaled down returned lower annual figures.

The survey also indicated that cumulative discard and slurry is only half of what is recorded in the register by means of the monthly returns. The survey records 494 million tonne on dumps and in ponds while the register records 1,024 million tonne. This significant difference is partly explained by the following:

- Questionnaires not returned by some mines;
- Incomplete returns with respect to tonnage;
- Mines depositing discards and slurry together with overburden, into old open-cast voids and not recording tonnages for the survey;
- Historical information of older dumps unknown and not included in the returns; and
- Ownerless and abandoned discard dumps not recorded in the survey.
The self-executing GIS should be considered as the first attempt to record an inventory of discard and slurry by modern electronic means. It is an extremely valuable tool for accessing the data-base and can be updated as and when required.

Notably this exercise was carried out in the strictest confidence and is only accessible through the Energy Division of the Department of Minerals and Energy.
INTRODUCTION

Coal continues to remain South Africa’s prime energy source with coal fired power generation by ESKOM (87.4 million tonne) and gasification by SASOL (48.8 million tonne) leading local coal consumption. Beneficiated coal is also exported (69 million tonne) while raw sized coal is also consumed for cooking and heating in South Africa’s townships.

Discard coal and slurry are currently being produced at annual rates in excess of 42 million and 11 million tonne respectively. Dumping of raw duff has ceased almost completely and previously dumped duff has been mostly reclaimed where possible.

Since the 1985 Inventory annual discard production has increased from 43.6 million tonne (1985) to 66.2 million tonne (2001). The 2001 survey records only 53.8 million tonne of discard and slurry deposition. The differential is explained as follows:

- nineteen smaller mines did not respond to the 2001 survey, accounting for some four million tonne;
- a group of KwaZulu-Natal mines were in liquidation at the time and did not respond; and
- mines that had scaled down returned lower annual figures.

It is not envisaged that the above-mentioned rates of discard deposition will be maintained because of the following reasons:

- Closure of a number of collieries including numerous very large producing collieries.
- The increase of raw coal being sent to utilities using this type of coal, namely ESKOM and SASOL.
- The production of a middlings product to supply ESKOM and SASOL.
- The blending of discard, raw coal and slurry for the power generation sector.
- Reclamation of slurry ponds to supply ESKOM.
The majority of the larger discard dumps are situated in Mpumalanga Province with a large number of smaller defunct dumps in KwaZulu-Natal Province.

Utilisation of both discard coal and slurry is being practiced on some mines. Discard coal is being re-washed for power station feed, while slurry ponds are being re-treated by froth flotation, producing a saleable product, which is blended with coarser coal fractions and sold as export steam coal or power station feed.

With environmental laws becoming stricter, mines are paying greater attention to the methods of discard and slurry disposal. Discard coal is now being compacted and the discard dump clad with soil and vegetated. These rehabilitated dumps are potentially reclaimable, the discard being kept under non-oxidising conditions.

A substantial amount of discard has either been tipped into opencast voids or mixed with opencast overburden material to fill voids left by the mining operation. This discard is considered un-reclaimable.

Numerous collieries are using compacted current discard, to cover or blanket old, smouldering or burnt-out discard dumps to prevent further pollution. This discard is potentially reclaimable but will be difficult to recover.

Methods of slurry disposal have also changed considerably. Slurry is now pumped into the centre of the dump, the compacted discard forming a wall around the central slurry impoundment. This form of co-disposal will have a marked affect on the discard reclamation. Slurry is sometimes pumped onto the un-compacted discard coal resulting in a matrix, which does not require intensive compacting, to form a non-oxidising condition within the dump. This method of slurry disposal is known as integrated discard disposal and will also affect discard reclamation.

On numerous opencast operations slurry has been pumped into the voids and once dry covered with overburden, this slurry is considered un-reclaimable. Certain mines
have however pumped slurry into, well prepared, opencast voids, this slurry being potentially recoverable. Slurry pumped into old underground workings as backfill is also considered un-reclaimable.

The larger mining houses responded well to the questionnaire but returns’ from smaller mines was disappointing. Information from the mines was used to prepare an information data-base and a Geographical Information System (GIS). A literature survey was also conducted and forms part of the data-base.

All information received was treated as strictly confidential.

The survey does not include ownerless, abandoned or State-owned discard facilities, however these can be included into the data-base as and when the information becomes available.

Information from both the Minerals Bureau “Operating and Developing Coal Mines” and the South African Bureau of Standards “Quality Bulletin No.113” were used to indicate the positions of collieries on the maps used in this report.

**METHODOLOGY OF THE SURVEY**

A questionnaire was compiled by the contracted consultants, Badger Mining and Consulting (Pty) Ltd and submitted to the Energy Branch of the Department of Minerals and Energy and to the National Discard Coal Steering Committee (NDCSC) for their approval. Once accepted the questionnaire together with a letter penned by the DME and signed by the Director General was sent to all company Chief Executive Officers. A hard copy and a computer disc of the questionnaire were also sent to all Mine Managers on the circulation list. Questionnaires were also were also given to responsible individuals at technical meetings, symposiums and professional association meetings.
A high profile, by all involved, was maintained, regarding the questionnaire. A pro forma of the questionnaire is included as Annexure 1.

The returned questionnaires were first capture electronically (if not already in that format) and standardised and formed the data-base which in turn formed the platform of the Geographical Information System. A comprehensive digital map of the relevant coal mining areas was purchased from the Surveyor General’s office and this forms the navigation tool of the GIS.

RETURN OF QUESTIONNAIRES

Questionnaires covering 142 discard and slurry disposal facilities were returned. Reasons for non-returns of questionnaires were.

- Colliery not producing discard or slurry.
- Colliery closed down.
- Information to sensitive.
- No reasons given.

It is estimated that the survey includes more than ninety percent of the current discard facilities expressed on a tonnage basis.

SIZE OF DISCARD DUMPS

The size of the discard dumps in the survey varied from 18 thousand tonne for the smallest dump to 32 million tonne for the largest.

Forty-seven percent of the questionnaires did not return any figures. The reason for this was mainly due to small defunct dumps, rehabilitated dumps and discard disposed with overburden into open cast voids.
Ninety-four percent of the discard tonnage was from bituminous coal mining operations while six percent was from anthracitic coal mining operations.

Figure 1 shows the breakdown between active and defunct discard dumps.

From Figure 1 above it can be seen that 72 percent of the discard dumps smaller than 5 million tons are defunct.

The average life of the active discard dumps, smaller than five million tonne is 11 years, therefore it is expected that these dumps will grow considerably.
SIZE OF SLURRY PONDS

The size of the slurry ponds in the survey varied from 6 thousand tonne for a facility just started, to 5.7 million tonne for the largest slurry pond which is active.

Responses to this section were poor, only 17 percent of the questionnaires recording tonnages. The poor response is due mainly to the fact that 65 percent of the facilities are defunct and a further six percent had pumped slurry into opencast voids and some mines had pumped slurry underground.

Figure 2 shows the breakdown of the present 52.779 million tonne of slurry.

![Figure 2](image)
AGE OF ACTIVE AND DEFUNCT DISCARD DUMPS

Figure 3 shows the age of discard dumps throughout the coalfields.

![Figure 3: Age of Discard Facility](image)

The average age of active discard facilities is 15 years, while the average age of defunct dumps is 50 years.
LAND AREA COVERED BY DISPOSAL FACILITIES

The establishment of discard dumps and slurry ponds utilizes many hectares of countryside. In most cases, even if the dump is rehabilitated, these disposal facilities remain as unsightly mounds on flat ground or protrusions on the sides of hills, depending on where they were established.

Discard dumped in opencast voids help to fill the area, however such discard is most often lost to further treatment. The same may be said for slime pumped underground as backfill, however this method of disposal helps to prevent surface collapse.

Figure 4 shows the area in hectares occupied by discard facilities.

![Figure 4](image)

The total area covered by discard and slurry disposal facilities amounts to 4,011 hectares. The largest area, 394 hectares, is a mined out opencast area. Thirteen other mines are also using large opencast voids. As previously mentioned the discard coal and slurry disposed of in this manner is, in most cases, considered un-reclaimable.
CURRENT DISCARD PRODUCTION

All the large collieries except for one responded. Annual discard production obtained from the data-base was 42.524 million tonne. It is estimated that this figure could be 10 to 15 percent higher.

Figure 5 shows the current discard produced by the major collieries.

Very few responses to the questionnaire split their produced discard into coarse discard (discard in the size range from 100mm to 12mm), smalls discard (discard in the size range from 12mm to 0.5mm) and fines discard (discard in the size range from 500µ to 100µ)

A number of collieries did however include crushing-liberation test-work and discard washability data for their respective discards. This information will be invaluable for further discard utilisation work.
Mines supplying coal to power stations are now finding it economical to re-wash discard to produce a middlings product for sale to the power-station, thereby reducing the amount of discard produced considerably.

Re-washing is normally carried out in jigs or in small Dense Medium Cyclone (DMS) plants. The discard is normally crushed to 30mm in order to improve recoveries by liberating the coal from the shale and gangue material.

Power stations benefit from this middling product, which normally has the same heat value as the raw coal, but a lower abrasion index and more often than not, lower sulphur content, due to the re-washing process.
CURRENT SLURRY PRODUCTION

Annual slurry production obtained from the data-base was 11.289 million tonne. It is estimated that this figure could be 10 to 15 percent higher.

Figure 6 shows the current slurry produced by the major collieries.

Treatment of slurry and the reclamation of slurry ponds for beneficiation by froth-flotation are being carried out by a number of mines. Beneficiation is carried out in either column flotation cells or in conventional tank type flotation cells. Product quality and recovery is normally good due to the better quality of the slurry when compared to the discard coal. The treatment of old oxidised slurry ponds does have a deleterious effect on both product yield and quality.
Dewatering of the fine slurry is normally a major process problem. Slurry product is normally dewatered with spiral concentrate in screen-bowl centrifuges, the dewatered product being blended with coarser coal for export. Blending of the products tends to produce acceptable moisture contents for export. Some collieries have installed more sophisticated dewatering equipment such as filter presses to maximise the reduction of the high moisture content of the slurry.
DISCARD QUALITY

The responses to the discard-quality questions were poorly completed. Quality information was confined mainly to the active discard dumps and the more recently closed defunct dumps. The main contributors to this section were the larger mines.

Graphical representation is on a tonnage basis with the number of discard facilities shown above the tonnage bar graph.

Calorific Value of Discard

Figure 7 gives the distribution of Discard calorific value obtained from the survey.

![Figure 7](image)

The discard dumps with calorific values above 21.00 MJ/kg are all small dumps. Three potentially reclaimable dumps, with a total tonnage of 1.434 million tonne are in the Breyton area, while a further three with a total potential tonnage of 1.605 million tonne are in the Witbank area. The latter three dumps have been devolatilised.
Ash Content of Discard

Figure 8 gives the distribution of Discard Ash obtained from the survey.

In some cases the mine has given the ash content of the discard but not the tonnage on the discard dump. This results in facilities being shown but no related tonnages.
Volatile Matter Content of Discard

Figure 9 gives the distribution of Discard Volatiles obtained from the survey.

![Figure 9](image)

The tonnage of discard in the 28 to 30 percent volatile range amounts to 1.434 million tonne and is largely related to those discard dumps with high calorific values as depicted in Figure 7.
Fixed Carbon Content of Discard

Figure 10 gives the distribution of discard Fixed Carbon obtained from the survey.

![Figure 10](image)

No mines recorded discards with a Fixed Carbon content lower than 18 percent.
Sulphur Content of Discard

Figure 11 gives the distribution of Discard Sulphur obtained from the survey.
POTENTIALLY RECLAIMABLE DISCARD.

Table 1 gives a summary of potentially reclaimable discard dumps with calorific values of better than 16MJ/kg. It has been accepted that discard with a heat value of 16MJ/kg can be utilized in special types of heat generating equipment. Beneficiation of feed coal of this quality will normally produce a good recovery of power station feed-stock or, in many cases, an economically viable recovery of export quality coal. Size reduction of the larger size discard fraction prior to washing will, in most cases, enhance the overall recovery due to improved liberation.

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Discard dumps with calorific values as low as 14 MJ/kg may well be suitable for upgrading by jigging or dense medium washing. This would bring further discard dumps with a combined tonnage of 40.765 million tonne into play.
SLURRY QUALITY

In general the slurry quality is higher than that of the discard but reclaiming and treatment are far more difficult and expensive.

Calorific Value of Slurry

Figure 12 gives the distribution of Slurry CV obtained from the survey.

![Figure 12: Slurry Calorific Value](image)
Ash Content of Slurry

Figure 13 gives the distribution of Slurry Ash obtained from the survey.

In some cases the mine has given the ash content of the slurry but not the tonnage on the slurry pond. This results in facilities being shown but no related tonnages.
Volatile Matter Content of Slurry

Figure 14 gives the distribution of Slurry Volatiles obtained from the survey.

In some cases the mine has given the volatile content of the slurry but not the tonnage on the slurry pond. This results in facilities being shown but no related tonnages.
Fixed Carbon Content of Slurry

Figure 15 gives the distribution of Slurry Fixed Carbon obtained from the survey.

In some cases the mine has given the fixed carbon content of the slurry but not the tonnage on the slurry pond. This results in facilities being shown but no related tonnages.
Sulphur Content of Slurry

Figure 16 gives the distribution of Slurry Sulphur obtained from the survey.

In some cases the mine has given the sulphur content of the slurry but not the tonnage on the slurry pond. This results in facilities being shown but no related tonnages.
POTENTIALLY RECOVERABLE SLURRY

All the slurry disposed of has a quality, which will lend itself to beneficiation by froth flotation to produce power station feedstock or even an export product. Slurry even has the potential to be utilized in its raw state provided the moisture content of the initial dried product can be reduced. The clogging and caking properties of slurry is a major drawback resulting in its use being extremely limited. Briquetting, however, may be a solution to managing and transporting slurry material with acceptable qualities.

DISCARD DISPOSAL FACILITIES AND THE ENVIRONMENT

Old discard dumps in South Africa are one of the greatest polluters of the environment, polluting the atmosphere, rivers, ground water and the esthetics of the countryside. In the latter years control over the disposal of discards and slurry by collieries has improved significantly. Free-tipping of coarse discard over the sides of discard dumps has been replaced by spreading of the discard and compaction to eliminate the ingress of air into the dump, thereby greatly reducing the chances of spontaneous combustion of discard on the dump. Discard facilities are now being clad with soil and vegetated to prevent all forms of atmospheric pollution. Dumps are now being constructed with run-off paddocks to control storm water run-off from the top and sides of the dump. Seepage from the dumps is now being monitored and collected in paddocks for re-use in the processing plant or gravitated to evaporation dams for evaporation purposes.

A large number of mines have now realised that their discard dumps and slurry ponds are valuable assets and could be utilized in the not too distant future. This realization and the introduction of stricter environmental standards have largely controlled pollution from the more recently established discard facilities.
Table 2 gives a summary of the condition of the 142 discard facilities encompassed in the survey.

Table 2

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OPERATING / CLOSED COLLIERY

All the mines completing the survey and a large number of mines not returning the questionnaire have been categorized into the nineteen coalfields according to the Minerals Bureau classification. These collieries have been positioned on one of three area maps for general identification. An identification list accompanies the three maps.

CONCLUSION

The survey covered the major coal producers operating in the Republic of South Africa. A number of important points have been highlighted by the survey.

- The dumping of Duff (-6mm) coal has ceased completely. This is due mainly to advances in processing technology and market demand.

- Changes in environmental legislation and the mine’s realization that discard is a valuable energy source has changed the way discard is now being considered. Discard facilities are now compacted and rehabilitated to preserve this resource.

- Discard and slurry are now being re-treated to produce an acceptable middlings coal for utilisation as an energy source.

- The number of burning and smoldering dumps has been considerably reduced.

- Most of the mines do not determine the quality of their discard by size fractions or do not report the information separately.
• The quantity of current discard produced has reduced in tonnage from the 1985 survey, due mainly to the closure of a number of large collieries.

• The data on ownerless discard facilities, which are normally high environmental risks, is difficult to obtain with any degree of accuracy.

Discard remains an enormous source of potential energy and surveys such as the 1985 and 2001 survey highlight the necessity to utilize these discard deposits to their fullest, thereby reducing the effect of all forms of environmental pollution.

It is recommended that the above type of survey coupled to the changes in process and utilisation be carried out at shorter intervals to keep up with the rapid advance of new and promising technologies.

This report is purely a summary of the comprehensive data-base and Geographical Information System lodged with the Department of Minerals and Energy which is a powerful tool in the overall discard inventory system.